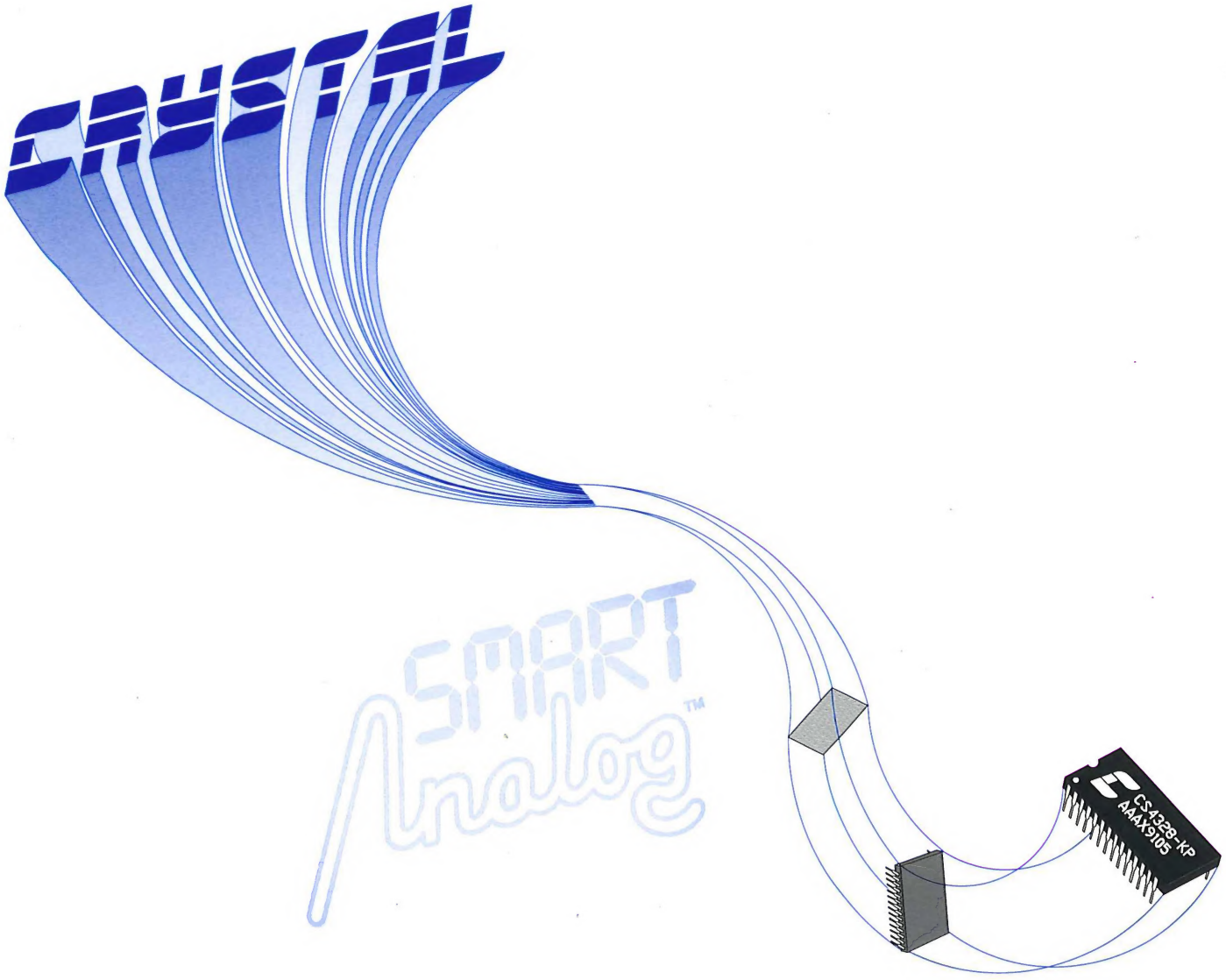
CRYSTAL SEMICONDUCTOR PRODUCT GUIDE



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CRYSTAL SEMICONDUCTOR CORPORATION

CONTENTS

At Crystal Semiconductor, our success is built on being the *most innovative* Analog Integrated Circuit company. We have an impressive string of "firsts" to back up that claim:

- The first monolithic T1 line interface.
- The first 16-bit monolithic analog to digital converter (ADC).
- The first CMOS Ethernet Transceiver
- The first monolithic Delta-Sigma ADC.
- The first monolithic 20-bit dc measurement ADC.
- The first monolithic signal processing ADC with 130 dB dynamic range.
- The first DAC SCF analog output filter with 97 dB dynamic range.

Achieving better performance, along with more integration, is a Crystal hallmark. For example, our CS5016 16-bit monolithic converter out-performs most hybrid devices; at lower cost, with better reliability and with consistent long-term stability. For our customers, this means better system performance with greater reliability as well as lower design and manufacturing costs.

SMART *Analog*™ design techniques uniquely combine complex analog functions with powerful digital circuitry to build the most capable analog circuits in the industry.

SMART *Analog*™ techniques have also yielded the world's best T1 line interface family. These parts incorporate programmable output pulse shapes to compensate for different cable lengths and a pullable crystal output oscillator yielding superb jitter attenuation capability.

Digital audio technology is rapidly supplanting traditional linear audio architectures. Crystal is the industry leader for A/D converters and D/A converters, based on our proprietary delta-sigma one -bit oversampling designs. Our devices have achieved global recognition because of their high level of integration, ease of use and superb sound quality. Crystal also supplies audio devices optimized for computer multimedia applications. Transmission of audio data between digital systems is facilitated by our family of AES/EBU & S/PDIF transmitters and receivers.

Crystal's most recent market entry is Local Area Network devices. Our chip set for Ethernet is industry's first 100% CMOS solution. The CS83C92 transceiver (TAP) chip is pin compatible to the industry-standard bipolar device and consumes only one-half the power.

Every Crystal Semiconductor product undergoes qualification testing before release to production. Both long-term and infant-mortality testing are used to identify any weaknesses. Qualification is performed on 3 non-consecutive lots using military specifications as guidelines (See Table below).

TEST	MIL STD 883C METHOD	CONDITION	INFANT MORTALITY TESTS		LONG-TERM RELIABILITY TESTS		
			DURATION	PASS/FAIL CRITERION	DURATION	PASS/FAIL CRITERION	CRYSTAL GOAL
OPERATING LIFE	1015 COND D	+125 °C, Dynamic Bias +/-5.5V Supplies	168 hrs	0.25%	1000 HRS	75 FITS †† (25 °C/60%UCL 1.0 eV Act. Energy)	10 FITS † (25 °C/ 60% UCL)
TEMPERATURE HUMIDITY STRESS (Plastic Parts)		+85° C/85% RH Static Bias	168 hrs	1.0 LTPD	1000 HRS	3.0 LTPD	1.0 LTPD
TEMPERATURE CYCLING Hermetic Packages	1010.5 COND C	-65° C to + 150 °C Then Gross Leak Test	100 CYCLES	1.0 LTPD	1000 CYCLES	3.0 LTPD	1.0 LTPD
TEMPERATURE CYCLING Molded Packages	1010.5 COND B or *	-55° C to + 125 °C or -40° C to + 125 °C	100 CYCLES	1.0 LTPD	500 CYCLES	3.0 LTPD	1.0 LTPD
THERMAL SHOCK	1011.4 COND B or **	-55° C to + 125 °C or -40° C to + 125 °C *** Then Gross Leak Test	100 CYCLES	1.0 LTPD	500 CYCLES	3.0 LTPD	1.0 LTPD
AUTOCLAVE (Plastic Parts)		+121 °C/100% RH 2 Atmosphere, No Bias	48 HRS	1.0 LTPD	144 HRS	3.0 LTPD	1.0 LTPD
CENTRIFUGE	2001	30 Kg/Y1 Axis				5.0 LTPD	1.0 LTPD
ELECTROSTATIC DISCHARGE	3015			1500V-0 Fail	5 UNITS, ALL PINS	1500V-0 FAIL	4000V
LATCH UP		dc Current		100 mA-0Fail	5 UNITS, ALL PINS	100mA-0 FAIL	200mA

* JEDEC STD 22-B A 104 COND B

** JEDEC STD 22-B A 106 COND C

*** For hermetic Packages Only

† Equivalent to to 50 FITS, 70 C/60% ULC, 0.7 eV

†† Equivalent to 300 FITS, 70 deg. C/60% UCL, 0.7 eV

Low Power T1, PCM-30 and ISDN Primary Rate Line Interface Circuits

Crystal Semiconductor offers a broad family of low power CMOS PCM line interface circuits, with each device optimized for a unique system application. The CS6152, CS6159, CS61535A, CS61574A and CS61575 are recommended for use in new designs. Since introducing the industry's first T1 and PCM-30 line interface circuits (the CS61534 and CS61544), we have shipped more CMOS PCM line interface ICs than any other vendor worldwide. Crystal Semiconductor's leadership continues with the best in pulse shapes, jitter attenuation, jitter tolerance and low power consumption.

T1 Transceiver

Our CS2180B T1 Transceiver is a perfect companion to our T1 line interface ICs. This device handles encoding and decoding of all T1 frame formats (D4, SLC-96 and T1DM and ESF). Serial interface and control registers make it simple to configure from a microprocessor, including per-channel control options. Packages available include 40-pin DIP or 44-lead PLCC.

Quartz Crystals

To complement our family of T1 Line Interface circuits, Crystal Semiconductor supplies pullable quartz crystals. The CXT6176 (for T1 applications at 1.544 Mbps) and CXT8192 (for PCM-30 applications at 2.048 Mbps) are designed for 100% compatibility with our PCM line interface and jitter attenuator circuits.

DTMF Receivers

Crystal has improved on industry standard DTMF receiver ICs while maintaining 100% pin compatibility. Our device features on-chip filters which offer the best possible signal-to-noise ratio allowing highly accurate decoding of telephone tones. Our CS20X family requires half the power of industry alternatives while providing 22 dB more dial tone rejection and better latch-up immunity.

Product	CS6152	CS6159	CS61535A	CS61574A	CS61575
Rate	T1	T1 & PCM-30	T1 & PCM-30	T1 & PCM-30	T1 & PCM-30
Receiver Functions	Data Slicer	Clock & Data Recovery	Clock & Data Recovery	Clock & Data Recovery & Jitter Atten.	Clock & Data Recovery & Jitter Atten.
Transmitter Functions	Driver	Driver	Jitter Atten. & Driver	Driver	Driver
Serial Control Port	-	-	✓	✓	✓
DIP Package	24-pin, .3"	24-pin, .3"	28-pin, .6"	28-pin, .6"	28-pin, .6"
Surface Mount	28-pin PLCC	24-pin SOIC	28-pin PLCC	28-pin PLCC	28-pin PLCC
AMI/B8ZS/ HDB3 Coder	-	-	✓	✓	✓
Jitter Tolerance of Receiver	> 300 UI	> 300 UI	> 300 UI	28 UI	138 UI

LINE INTERFACE COMPARISON TABLE

CS6152: Basic DSX-1 driver and receive buffer. For low power cards using digital-ASIC clock recovery. Ideal for trunk card bays where T1 density is limited by heat dissipation.

CS6159: Ideal for large synchronous systems such as central offices and DCS 0/1, which need the lowest cost per line, small package and low power consumption.

CS61535A: Enhanced transmit-side jitter attenuator supports SONET VT1.5 and VT2, and other high speed transmission systems such as digital microwave radio and M13 multiplexers.

CS61574A and CS61575: Receive-side jitter attenuation supports loop-timing in customer-premises equipment (which needs to meet AT&T 62411) and in channel banks.

LINE INTERFACE APPLICATIONS

Jitter Attenuation Circuits

Our jitter attenuation technology is available stand-alone for a wide variety of applications. The CS61600 is ideal for T1 and PCM-30 applications while the CS80600 attenuates jitter in T2, 2nd-level CEPT lines and Token Ring LANs. Both attenuators can be used with external divide circuits to handle low frequencies.

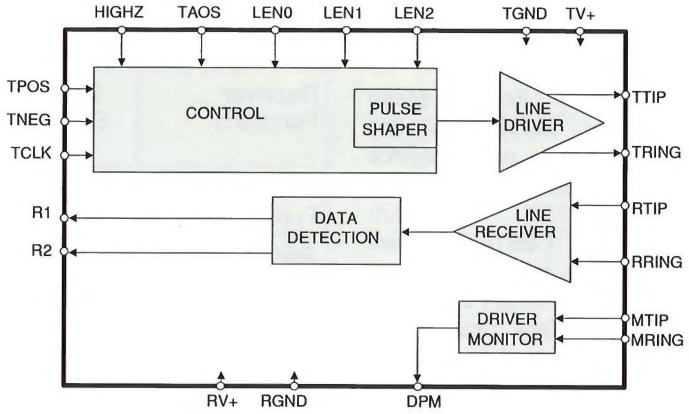
T3/E3/SONET Analog Receivers

Crystal's CS6300, CS6301 and CS7295 are high-performance analog receivers for T3(44 MHz), E3 (34 MHz) and SONET STS-1/OC-1 (51 MHz) applications. The devices provide line equalization, plus clock and data recovery. For optical applications, the line equalizer can be bypassed, allowing the output of an optical receiver to be input to the clock recovery section. The Phase Lock Loop used for clock recovery has continuous frequency calibration and matches the frequency of an external reference clock upon loss of signal.

CS6152

T1 Analog Interface

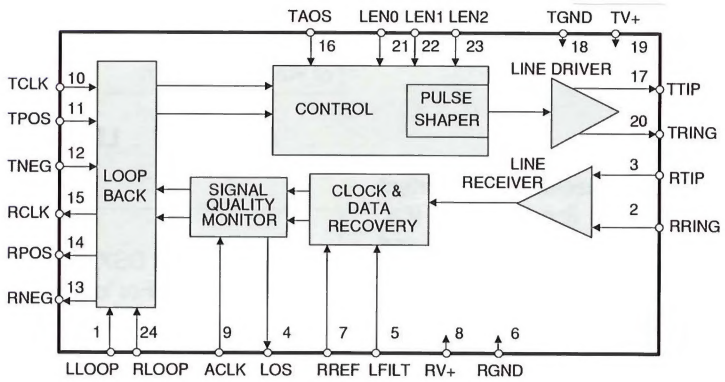
* Low power
* EXPERT Pulse™ line driver
* AMI to TTL receiver
* 300 mil DIP or PLCC package



CS6159

T1 & PCM-30 Line Interface

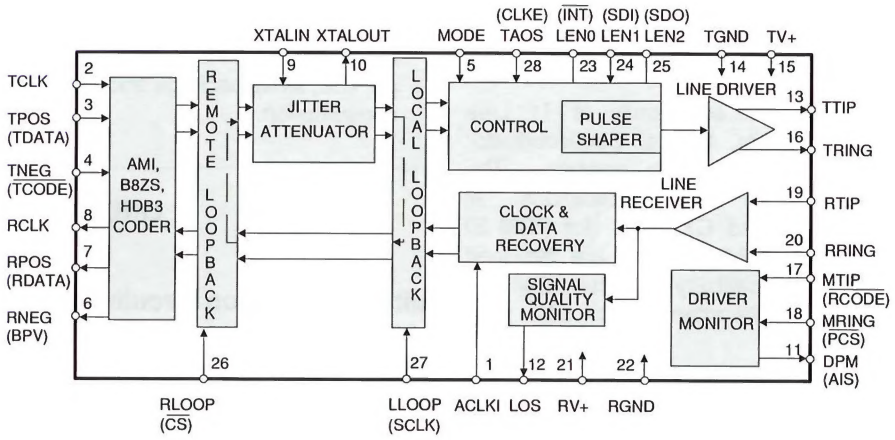
* EXPERT Pulse™ line driver
* Data and clock recovery
* Low power
* 300 mil DIP or PLCC package



CS61535A

T1 & PCM-30 Line Interface

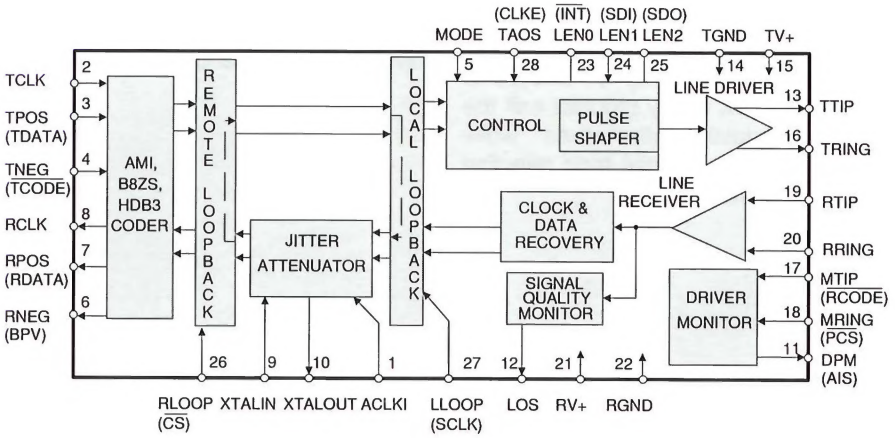
* EXPERT Pulse™ line driver
* Data and clock recovery
* Transmit-side jitter attenuator
* B8ZS/HDB3/AMI encoders/decoders



CS61574A

T1 & PCM-30 Line Interface

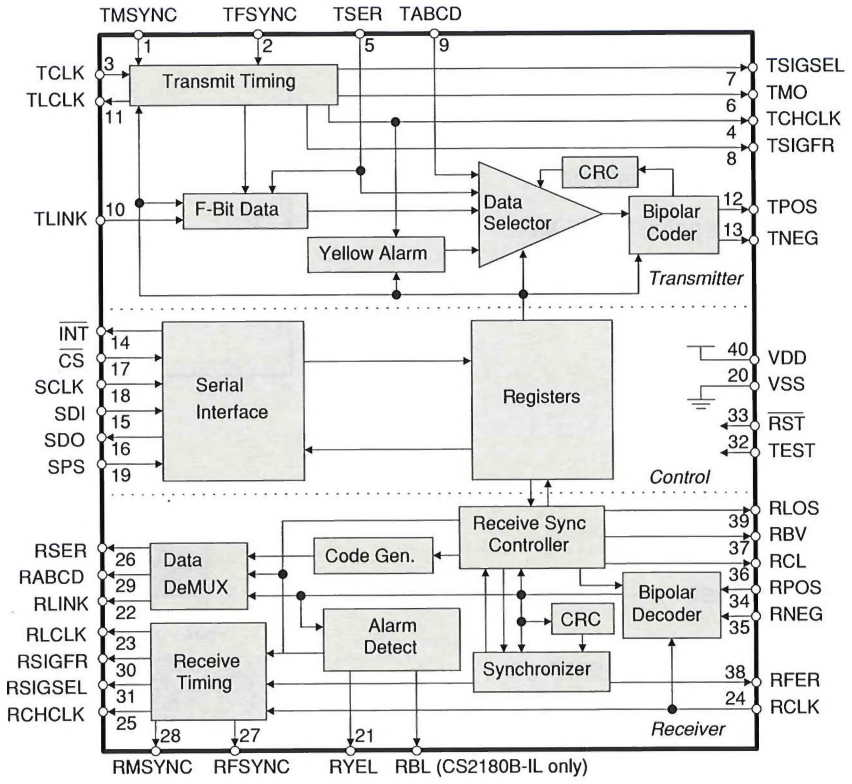
* EXPERT Pulse™ line driver
* Data and clock recovery
* Receive-side jitter attenuator
* Compliant to AT & T 62411



CS2180A,CS2180B

T1 Framing I.C.

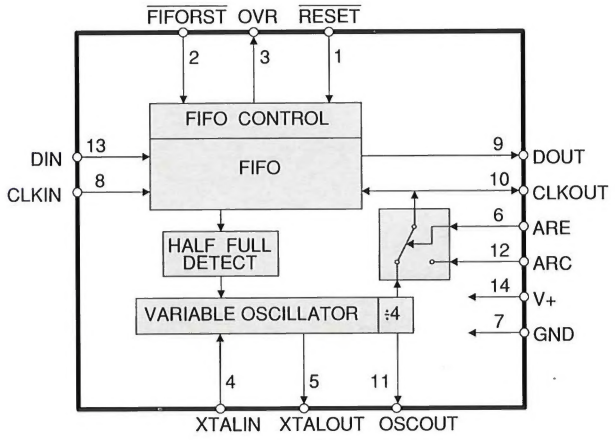
* D4 & ESF formats
* CS2180B also supports SLC-96 & T1DM formats
* CS2180B is pin compatible with CS2180A, DS2180A, DS2180



CS61600

T1 (1.544 MHz) or PCM-30 (2.048 MHz) Jitter Attenuator

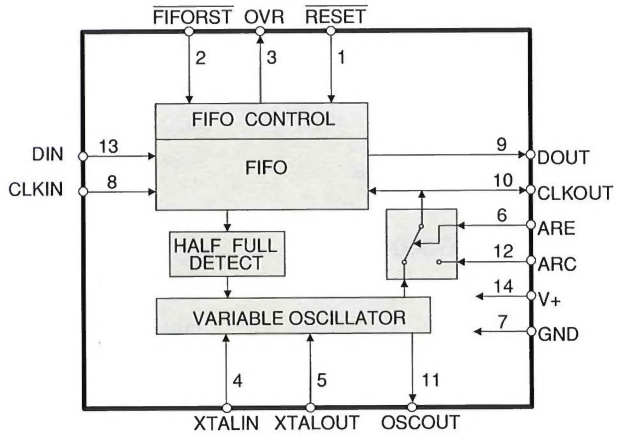
* Attenuates > 50 Hz jitter
* 16-bit FIFO
* Tolerates at least 7 U.I.
* 50 mW power
* 14 pin DIP



CS80600

General Purpose Jitter Attenuator

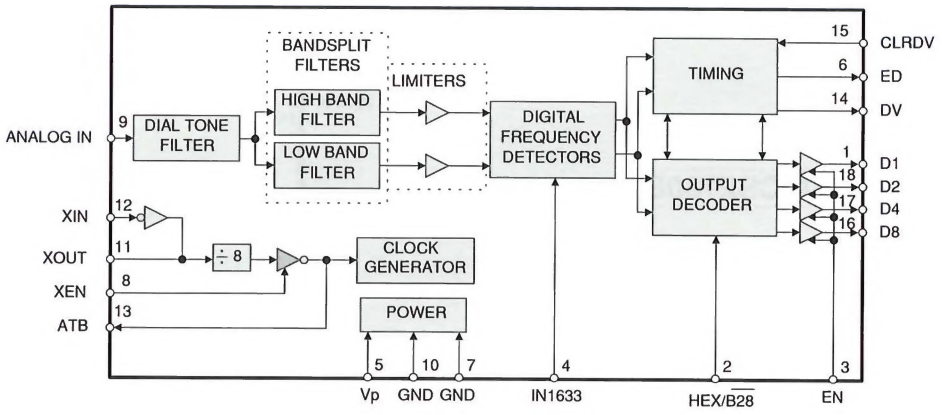
* 4.5 MHz to 8.5 MHz clock
* 8-bit FIFO
* Tolerates at least 3 U.I.
* Token ring applications
* T1C, T2, CEPT2 & 2nd order multiplexers



CS202,CS203,CS204

DTMF Receiver

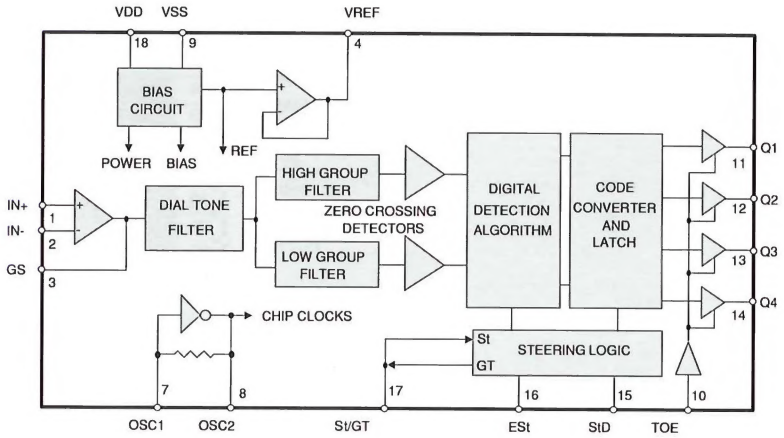
* Detects 12 or 16 tone pairs
* Uses inexpensive 3.579 MHz crystal
* Pin compatible SSI 202/203/204



CS8870

DTMF Receiver

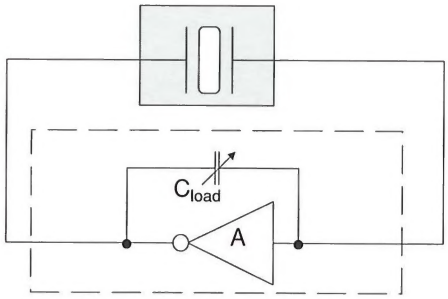
* Adjustable receiver sensitivity
* Adjustable detect and release time
* Pin compatible with MT8870B



CXT6176,CXT8192

Quartz Crystal

* 6.176 MHz or 8.192 MHz
* Optimized pulling characteristics
* Suitable for use with Crystal line interface integrated circuits and jitter attenuators.

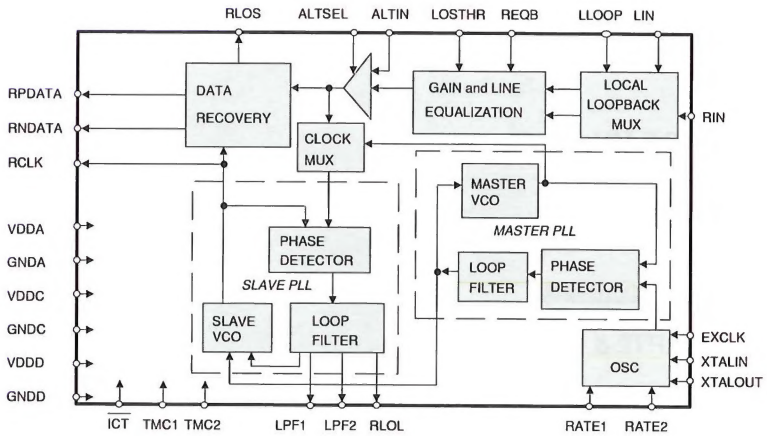


CMOS OSCILLATOR CIRCUIT MODEL

CS6300,CS6301,CS7295

Line Receiver for T3 & STS-1

* Line equalization, clock and data recovery
* Compatible with TR-TSY-000499 and TA - T54-000253



Crystal offers a complete Ethernet/Cheapernet hardware solution. The CS8005 is a sophisticated Advanced Ethernet Data Link Controller, which connects to the CS8023A Manchester Code Converter. Connection to the co-ax cable is achieved by the CS83C92C transceiver.

The CS8005 is a high-performance 16-bit Ethernet controller. The CS8005 uses a large dedicated local buffer memory, which off-loads the host CPU and CPU backplane. This local memory, along with a comprehensive command set, allows Ethernet capability to be added with minimal host CPU impact.

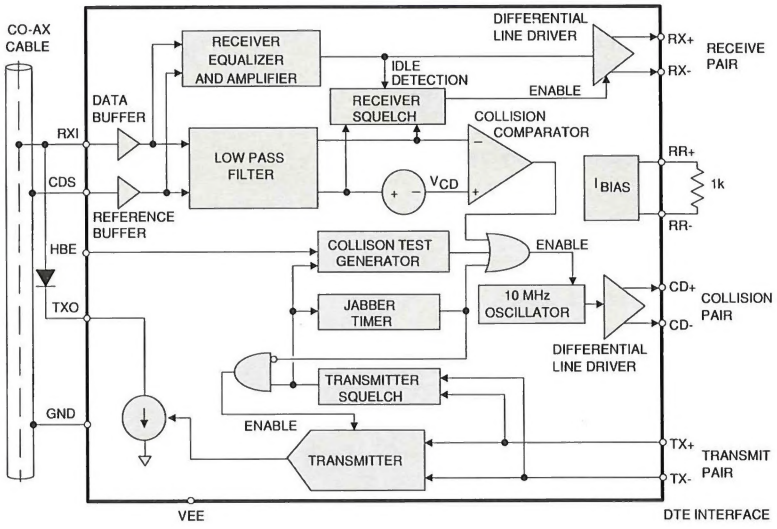
The CS8023A Manchester Code Converter is implemented in low-power CMOS, and requires only a single 5 V supply. The CS8023A is implemented in a high-voltage process allowing it to tolerate the required 16 V fault conditions.

Crystal is the first company to bring the benefits of low-power CMOS technology to Ethernet/Cheapernet transceivers. The CS83C92C uses up to 40% less power than the DP8392A and DP8392B. This translates into increased reliability and compatibility with surface mount technology. The CS83C92C is the first Ethernet transceiver which is fully compliant with ISO/IEEE 802.3.

CS83C92A,CS83C92C

Co-ax Transceiver

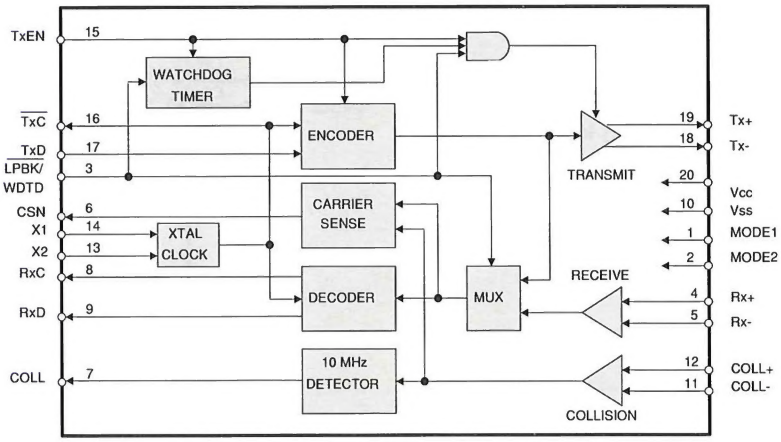
* Low power CMOS
* Pin compatible with National DP8392A/B
* CS83C92C is compliant with ISO/IEEE 802.3 10 base 5 (Ethernet) and 10 base 2 (Cheapernet)
* 16-pin DIP and 28-pin PLCC



CS8023A

Manchester Code Converter

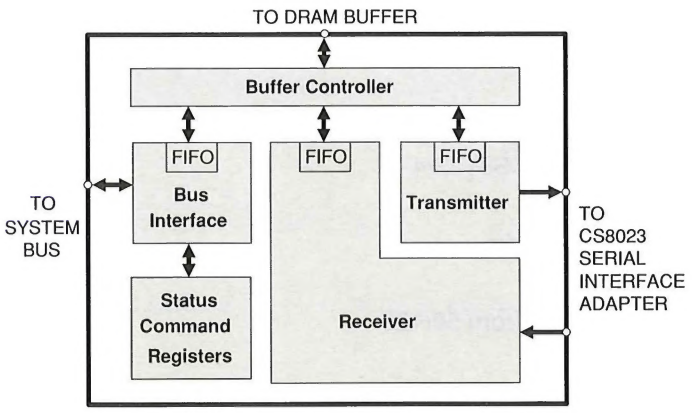
* Compliant with ISO/IEEE 802.3 and Ethernet Rev. 1
* Works with CS8005 and Intel 82586 controllers
* Low power CMOS



CS8005

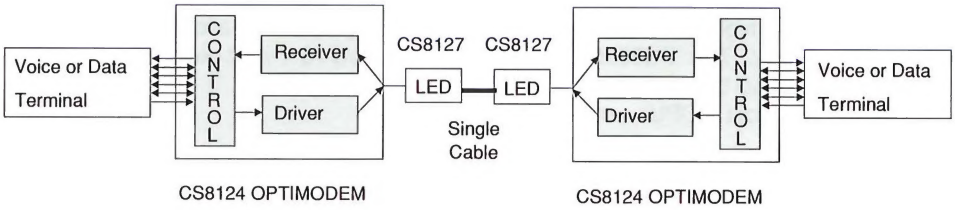
Ethernet Data Link Controller

* Refresh circuitry for DRAMS on-chip
* 64 K Byte local buffer
* Advanced error correction and handling
* Reduced external logic requirements
* Three separate FIFO's: receive, transmit and system



Optical Data Links

Crystal Semiconductor has smashed through cost barriers for optical links with new low-cost bi-directional OPTIMODEMS™. The CS8123 and CS8124 support full-duplex voice and data communications at speeds to 256 kbps, while using just one optical component at each end of the link. The CS8127 is a unique light emitting and detecting diode for use with OPTIMODEMS™. Applications for the family of optical data links include: secure (TEMPEST) communication of voice data at ISDN data rates; communication in electrically - noisy environments such as a factory floor; links where the physical size and weight of cables and connectors are a concern; and inter-building connections which require lightning immunity.

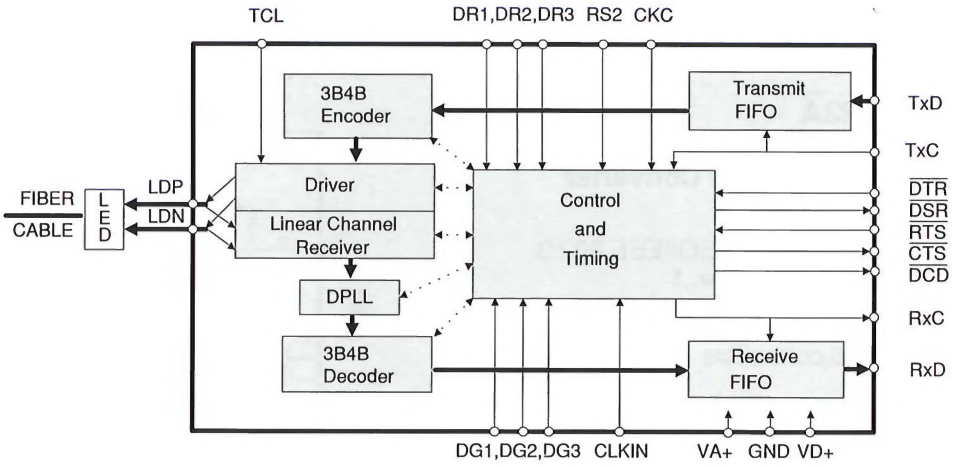


The OPTIMODEM™ is a powerful optical data link for a variety of applications.

CS8123,CS8124

Optical Modem I.C.

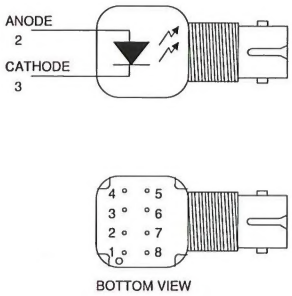
* Full duplex over 1 fiber
* Synchronous up to 25 kbps
* Asynchronous up to 38.4 kbps
* 10^{-9} BER up to 1.3 km
* T1 rate (1.544 mbps) transmit-only mode
* T1 rate receive-only mode



CS8127

840 nm LED in a plastic ST housing

* Supports bi-directional communication with CS8123/4 OPTIMODEM
* 40 µW output power into 50/125 µm cable
* 0.2 A/W responsivity from 50/125 cable



Pin	Function
1	NC
2	ANODE
3	CATHODE
4	NC
5	NC
6	NC
7	NC
8	NC

ANALOG TO DIGITAL CONVERTERS

Using SMART *Analog* technology, Crystal Semiconductor has created a family of CMOS A/D Converters which feature patented on-chip, self-calibrating architectures to maintain accuracy and linearity over their full temperature range and device lifetime. Each of our A/D Converters features an on-chip sample and hold, and is manufactured in low-power CMOS. Most devices include a power-down sleep mode.

General Purpose ADC's

CS5012A, CS5014, CS5016 SAR Family

The CS5012A, CS5014 and CS5016 converters have 12, 14 & 16 bits of resolution respectively, with conversion times of 7 µs to 16 µs. The converters are tested for static and dynamic performance, at full rated conversion speed. On-chip self-calibration ensures that linearity, offset and full-scale errors remain with specification, with no missing codes. Specifications are maintained over the full temperature range.

CS5101A, CS5126 16-bit 100 kHz ADC

The CS5101A is a 16-bit ADC capable of converting in 8 µs, yielding sample rates of 100 kHz. A 2-channel analog input mux is included. Output data is available serially, with 4 interface modes. An on-chip crystal oscillator is provided, along with a power-down control. The CS5126 is a low-cost version of the CS5101A, intended for single processing applications.

CS5102A 16-bit 25 kHz Low Power ADC

The CS5102A is a low power version of the CS5101A. Requiring only 44 mW from ±5 V supplies, along with a 1 mW power down mode, the 5102A is ideal for battery powered applications.

5412 12-bit, 1 MHz ADC

Using a 2-step flash approach, the CS5412 achieves 12-bit performance at 1 MHz sample rate. Self calibration insures accuracy over time and the military temperature range. Available in both DIP and J-lead LCC packages, with on-chip S/H, the IC offers a very compact ADC solution.

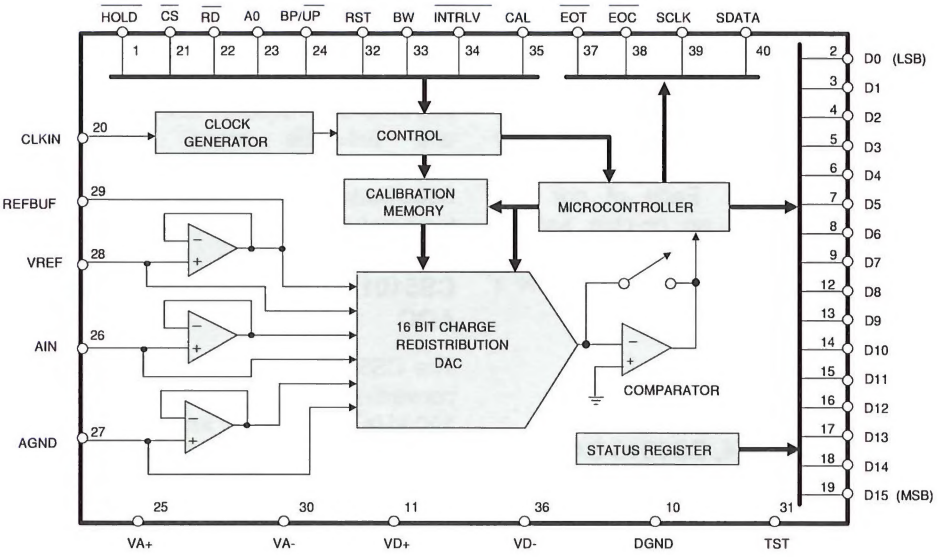
Specifications	CS5012A CS5014 CS5016	CS5101A CS5102A CS5126	CS5317	CS5322 CS5323 CS5324	CS5326/7 CS5328/9 CS5336/7 CS5338/9	CS5349	CS5412	CS5501 CS5503	CS5505 CS5506 CS5507 CS5508	CS5516 CS5520
Application	GP	GP	Modem	Seismic	Audio	Audio	GP Fast	DC Measurement		
Resolution (bits)	12/14/16	16	16	24	16/18	16	12	16/20	16/20	16/20
Conversion Time (us)	7/14/16	8/40	-	-	-	-	1.25	-	-	-
Throughput (kHz)	100/56/50	100/20	20	-	50	50	1 MHz	4	60/100Hz	60Hz
Number of Inputs	1	2	1	1	2	2	1	1	1/4	1
Input Bandwidth	-	-	10 kHz	500 Hz	22/20 kHz	22 kHz	4 MHz	10Hz	10 Hz	12Hz
Integral Non-Linearity	.006/.002/.001 %	.0015%	-	-	-	-	.01 %	.0007 %	.0015 %	.0007 %
Differential (± LSB) Non-Linearity	0.25/0.25/NMC	NMC	NMC	NMC	NMC	NMC	0.9	0.125/NMC	0.125	0.5
No Missing Codes	12/14/16	16	16	20	16/18	16	12	16/20	16/18	16/20
Total Harmonic Distortion (%)	.008/.003/.001	.001	.007	.0003	.0015	.0015	.02	-	-	-
Signal-to-Noise plus Distortion (dB)	73/83/92	92	80	-	92	87	70	-	-	-
Dynamic Range (dB)	73/83/92	92	84	120	95/100*	90	70	-	-	-
Power Needed (mW)	120	280/44	220	150	450/400	325	750	25	3	30
Conversion Method	Succ. Approx.	Succ. Approx.	Delta Sigma	Delta Sigma	Delta Sigma	Delta Sigma	2-Step Flash	Delta Sigma	Delta Sigma	Delta Sigma
Power Down Mode		√		√	√	√		√	√	√
On-Chip Sample and Hold	√	√	√	√	√	√	√	√	√	√
On-Chip V. Ref			√		√	√			√	√
On-Chip Filtering			√	√	√	√		√	√	√
Statically Tested	√	√					√	√	√	√
Dynamically Tested	√	√	√	√	√	√	√			
Temperature Range	Com Ind Mil	Com Ind Mil	Com Ind Mil	Com Ind	Com Ind Mil	Com Ind	Com Ind Mil	Com Ind Mil	Ind Mil	Ind Mil
Number of Pins (DIP)	40	28	18	28	28	28	40	20	20/24	24
Packages	DIP PLCC LCC	DIP PLCC LCC	DIP SOIC	PLCC	DIP SOIC	DIP SOIC	DIP JLCC	DIP SOIC	DIP SOIC	DIP SOIC

NMC=No Missing Codes * CS5328 In Mono Mode GP=General Purpose

CS5012A,CS5014,CS5016

12, 14, 16-bit Self Calibrating ADC's

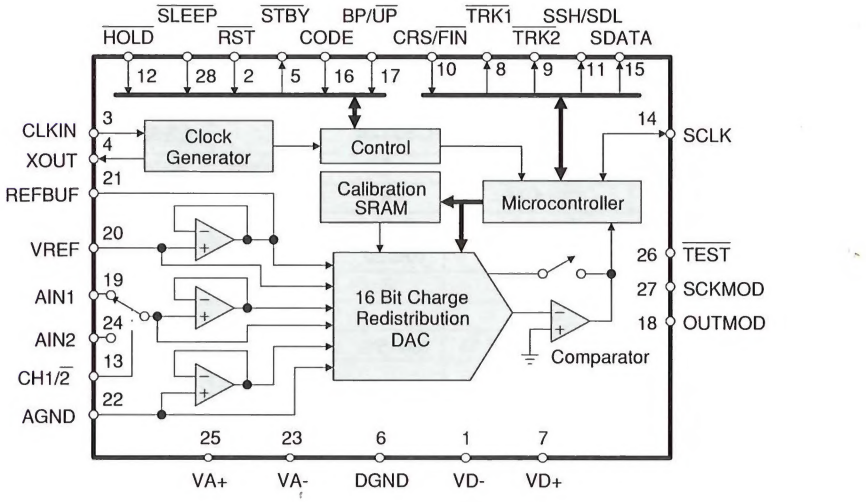
* 50 kHz to 100 kHz sample rate
* 8 µs to 16 µs conversion time
* 0.001% linearity
* No missing codes
* Low power consumption 150mW
* Built-in track & hold



CS5101A,CS5102A,CS5126

16-bit Self Calibrating ADC's

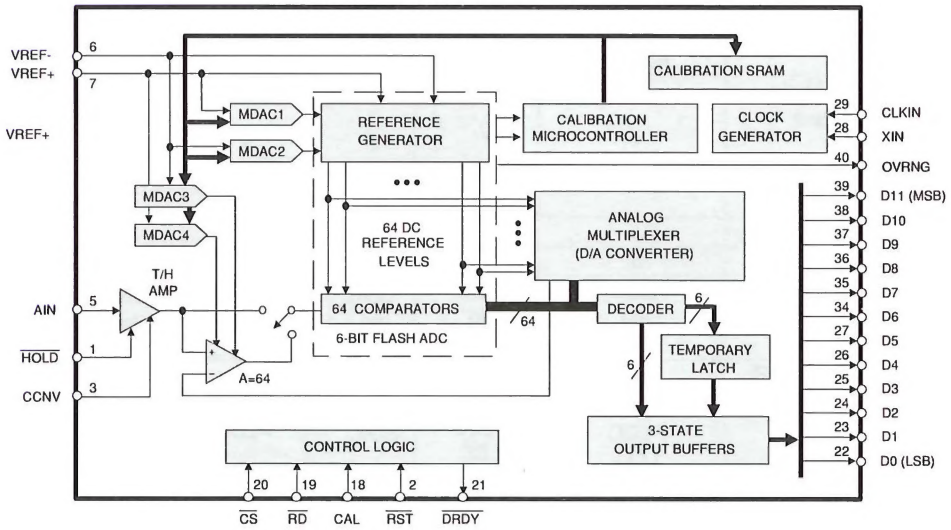
* 100 kHz or 20 kHz sample rate
* 8 µs or 44 µs conversion time
* 280 mW or 44 mW power consumption
* 0.001% linearity
* No missing codes
* Small 28 pin DIP or PLCC package



CS5412

12-bit Self Calibrating ADC

* 1 MHz sample rate
* Built in track & hold
* 72 dB dynamic range
* Linearity ±3/4 LSB
* No missing codes
* 750 mW power consumption



Intended for dc and low frequency measurements, Crystal offers a variety of ADC's for the weigh scale, process control, medical and seismic industries.

CS5501, CS5503 16/20-bit DC Measurement ADC

The CS5501 and CS5503 feature an on-chip, 6-pole, low-pass filter, with adjustable corner frequencies from 0.1 Hz to 10 Hz. The ADC's achieve linearity errors of 0.0007%, with no missing codes. A highly flexible serial interface, along with 25 mW power consumption, all in a 20 pin package, make the parts ideal for weigh scale and process control applications. The CS5503 is the 20-bit version of the CS5501, offering increased dynamic range, often removing the need for external gain scaling.

CS5505/6/7/8 4-channel, 16/20-bit DC Measurement ADC

Very low power consumption of 1.5 mW, along with a 4-channel input mux, make this part ideal for process control and hand held meter applications. These ADC's are available in 16 or 20 bit versions, with single channel or 4 channel inputs and DIP or surface mount packages.

CS5516,CS5520 16/20-bit Bridge Transducer ADC

The CS5516 and CS5520 are complete solutions for digitizing low level signals from strain gauges, load cells and pressure transducers. Any family of mV output transducers, including those needing bridge excitation, can be directly interfaced to the CS5516 or CS5520. The devices offer an on-chip software progammable instrumentation amplifier, choice of AC or DC bridge excitation, software selectable reference and signal demodulation.

CS5322, CS5323, CS5324, 24-bit Variable Bandwith ADC

The CS5323 modulator, combined with the CS5322 digital filter, offers >120 dB dynamic range in the DC to 500 Hz frequency band. Five different filter corner frequencies and output update rates are offered, allowing the ADC to be optimized for different types of seismic measurements. The CS5324 includes a modulator and the first stage of digital filtering, allowing users to implement their own final filter stage.

CS5317 16-bit Voice Band ADC

The CS5317 is well suited for a wide range of voiceband applications, from speech recognition to passive sonar. An on-chip PLL/Clock generator makes the part perfect for high-performance modems. The device features a 20 kHz word rate, a 10 kHz bandwith, 84 dB dynamic range and 80 dB THD.

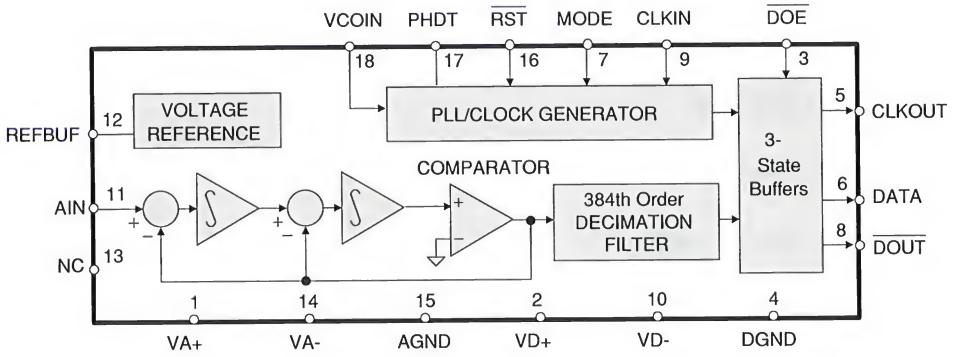
CS5336 Audio Bandwith ADC's

Selected members of our audio ADC family will be offered in industrial or military versions (See the Digital Audio Section).

CS5317

16-bit, delta-sigma ADC

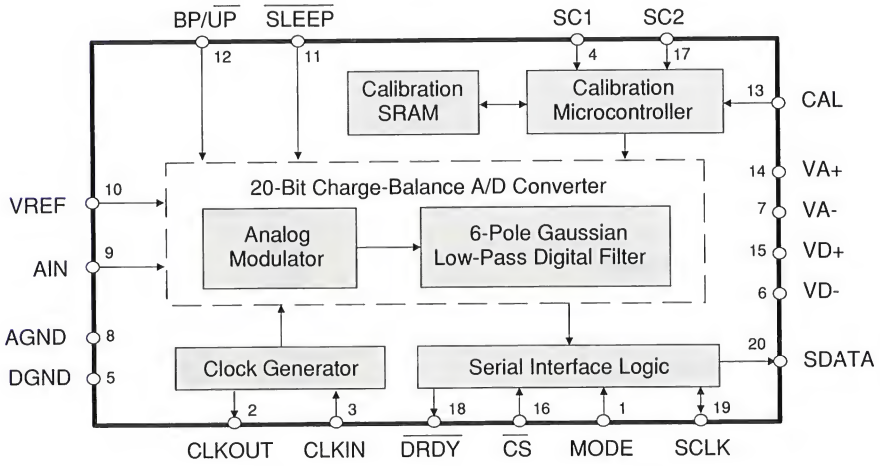
* Internal track & hold
* On-chip reference
* Digital filter
* 84 dB dynamic range
* 10 Hz to 10 kHz bandwith
* 20 kHz output word rate



CS5501,CS5503

16 or 20-bit CMOS ADC

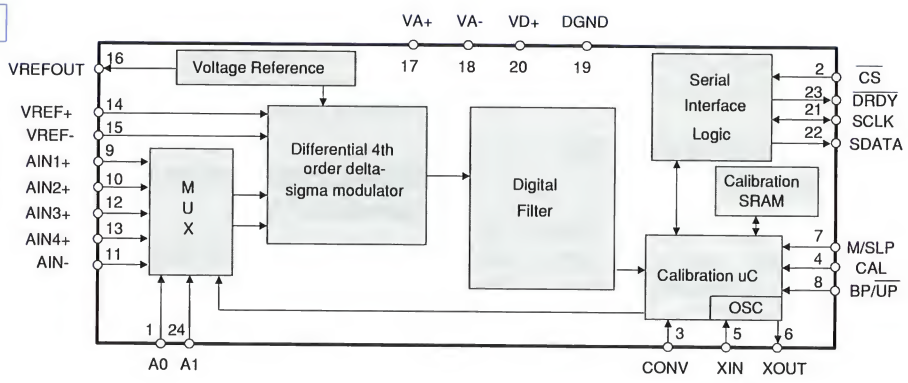
* dc to 10 Hz bandwith
* 4 kHz output word rate
* on chip digital filter rejects to 460 Hz
* 0.0015% linearity
* DNL ±1/8 LSB
* Self and system calibration
* 25 mW power, 10 μW sleep mode



CS5505,CS5506,CS5507,CS5508

16 or 20 bit CMOS ADC

* Very low power consumption of 1.5mW
* dc to 10 Hz measurements
* Built-in digital filter rejects 50 and 60 Hz
* 4 channel or 1 channel versions
* Internal track & hold

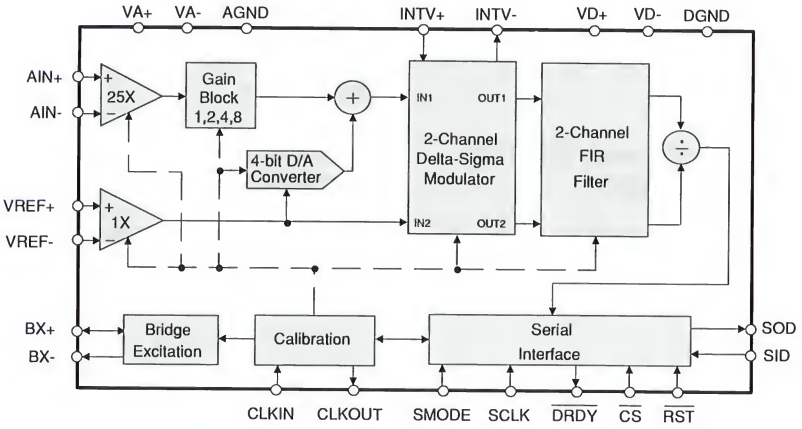


The CS5505/6 are illustrated. The CS5507/8 are single-channel differential input devices.

CS5516,CS5520

16 or 20 bit Bridge Transducer ADC

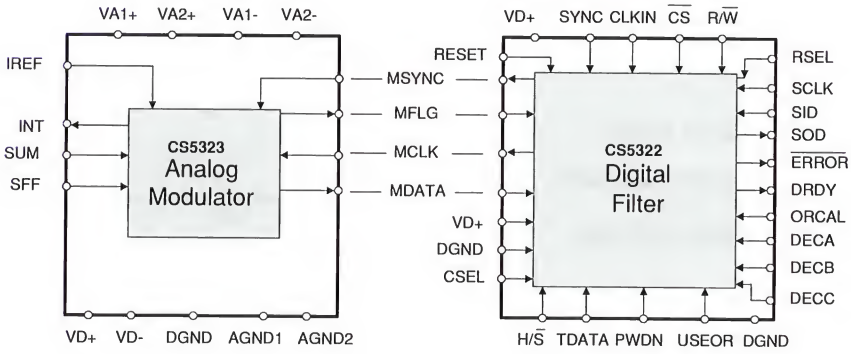
* On-chip instrumentation amplifier
* On-chip demodulators
* On-chip PGA
* 4-bit D/A for offset removal
* Low power consumption



CS5322,CS5323

24 bit ADC chip set

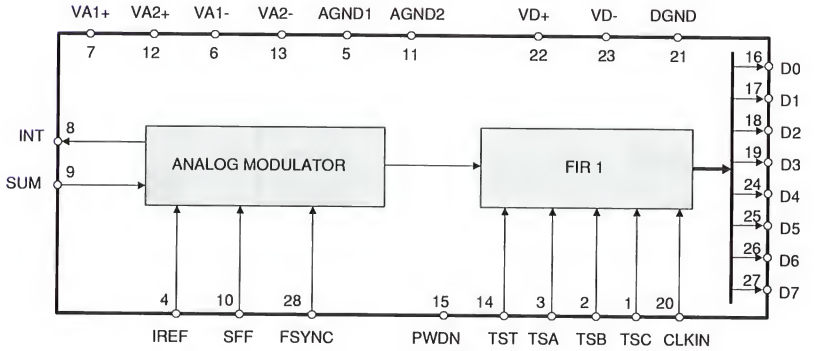
* 120 dB dynamic range
* Delta-sigma modulator
* Variable bandwith digital filter: 23/47/94/187/375 Hz
* Internal track & hold
* Low power consumption



CS5324

120 dB dynamic range ADC

* Delta-sigma modulator
* 1st stage FIR filter
* 32 kHz output word rate
* Internal track & hold
* Low power consumption



CS5326,7,8,9 and CS5336,8,9 Delta Sigma Audio A/D Converters

This new class of device features 64X oversampling, using a Delta-Sigma architecture with resolutions of 16 or 18-bits. Output word rates can be from 1 kHz to 50 kHz. These stereo parts have 2 sample and holds, dual Delta-Sigma modulators, two anti-aliasing and decimation filters, and a voltage reference, all in a 28-pin package. Performance measurements include 95 dB dynamic range in stereo mode, up to 100 dB in mono mode, along with 0.0015% THD.

CS5349 Single Supply, Stereo A/D Converter for Digital Audio.

The CS5349 is a complete, 16-bit analog-to-digital converter for stereo digital audio systems that require a single +5V supply. Similar to the CS5339, the CS5349 features 64X oversampling Delta Sigma conversion with on-chip sample and hold, filtering and voltage reference in a 28-pin package.

CS4328 Digital to Analog Converter

The CS4328 is the industry's first complete stereo digital-to-analog output system. This 18-bit stereo D/A converter uses Crystal's well established oversampling converter techniques.

The CS4328 includes the major system elements of 8X interpolation filter, 64X Delta-Sigma modulator, 1-bit D/A converter and a 124 dB signal-to-noise ratio analog anti-imaging filter, all in one packaged, tested, solution. The device features patented Delta-Sigma architectures to maintain excellent distortion performance, even at low signal levels. The output anti-imaging filters are the first to be based on a mixed linear/switched capacitor architecture. This approach is particularly insensitive to clock jitter and allows the benefit of scaling the bandwidth proportionally to the system master clock. The CS4328 is therefore adjustable for both audio and voice band applications. The flexible digital interface mates with CD player circuitry, DAT recorders and DSP's.

CS4303 Digital to Analog Converter

The CS4303 is an all digital I.C. containing an 8X interpolation filter and overall 64X oversampling delta-sigma modulator. Addition of an external analog reconstruction filter yields 107 dB dynamic range with superb low level linearity.

AES/EBU & S/PDIF Transmitters & Receivers

The CS8401/2 digital audio transmitters, along with the CS8411/2 digital audio receivers, allow digital communication between audio equipment. Requiring minimum external circuitry, these IC's support both the professional AES/EBU and consumer S/PDIF formats.

The CS8401 and CS8411 have a CPU interface, and must be controlled via a CPU. The CS8402 and CS8412 have dedicated interface pins, and do not need a CPU for control. The CS8411 and CS8412 receivers have low-jitter, on-chip clock recovery.

Multimedia Stereo Audio Codecs

The CS4215 and CS4216 are complete audio coders/decoders. Each device contains 2 A/D converters, 2 D/A converters, adjustable input gain and adjustable output level. Both digital and analog filtering is included, so no external analog filters are required. The CS4215 also has a microphone input, headphone output, and a monitor speaker drive. Potential applications include audio i/o for personal computers and workstations.

Audio A/D Converter Comparison Table

Device	CS5326	CS5327	CS5328	CS5329	CS5336	CS5338	CS5339	CS5349
Number of Bits	16	16	18	18	16	16	16	16
Dynamic Range (dB)	95	95	100*	100*	95	95	95	90
SOIC Package	-	-	-	-	✓	✓	✓	✓
Filter Passband (kHz)	0-22	0-20	0-22	0-20	0-20	0-22	0-22	0-22
Filter Transition Band (kHz)	22-26	20-24	22-26	20-24	20-26	22-28	22-28	22-28
Stop Band Attenuation (dB)	-86	-86	-86	-86	-80	-80	-80	-80
Overrange Tag Bits	-	-	-	-	✓	✓	✓	✓
Left/Right Tag Bits	-	-	-	-	✓	✓	✓	✓
Master Clocking Mode	-	-	-	-	✓	✓	✓	✓
SCLK active edge	↑	↑	↑	↑	↑	↑	↓	↓
Master Clock Frequency (XFs)	128	128	128	128	256/384	256/384	256/384	256/384
Power Supply Voltages (V)	±5	±5	±5	±5	±5	±5	±5	+5
Operation < 30 kHz without TEST Mode	-	-	-	-	✓	✓	✓	✓
Power Consumption mW	450	450	450	450	400	400	400	325

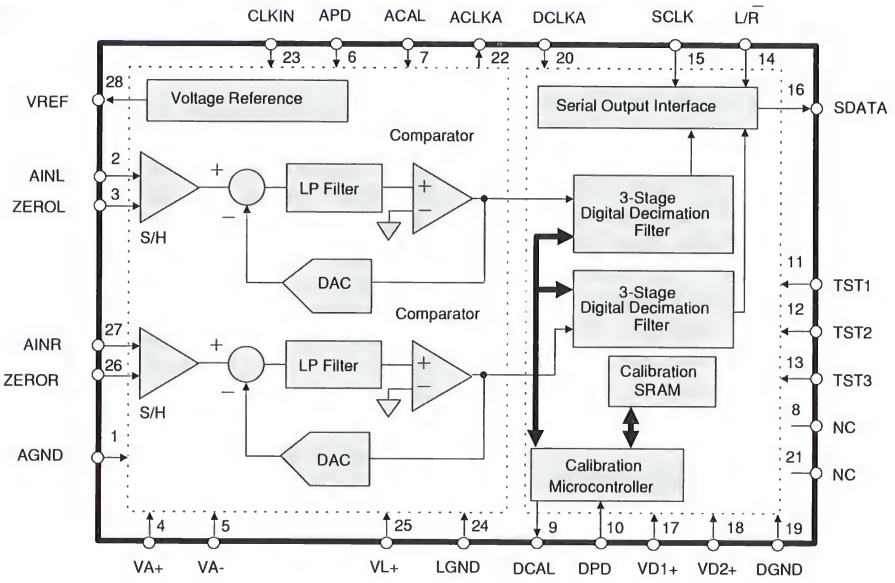
* In Mono Mode

All frequencies are with an output word rate of 48 kHz

CS5326,CS5327,CS5328,CS5329

Stereo Delta-Sigma A/D Converter

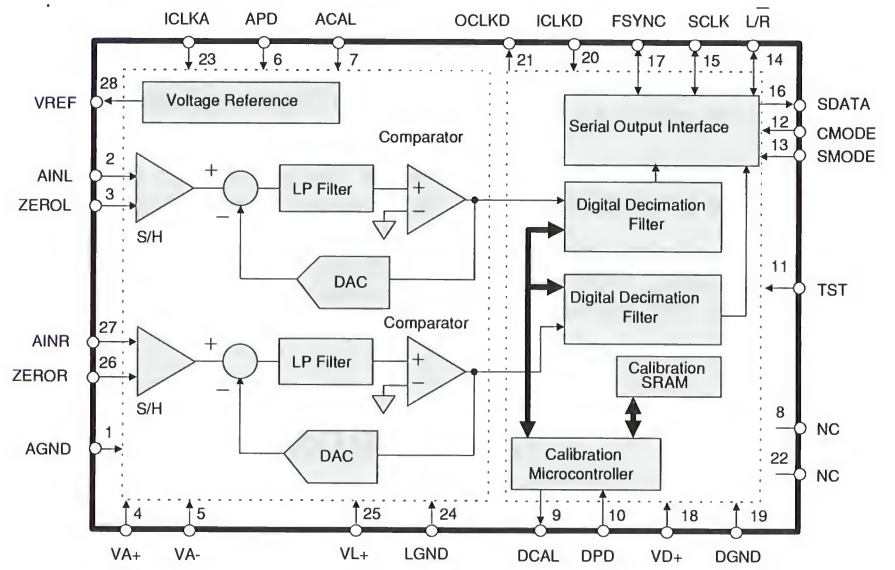
* 30 kHz to 50 kHz output word rate
* 95 dB dynamic range, 16-bit
  97 dB dynamic range, 18-bit
  100 dB dynamic range, 19-bit
  Mono
* Internal 64X oversampling



CS5336,CS5338,CS5339

Low Cost Stereo Delta-Sigma A/D Converter

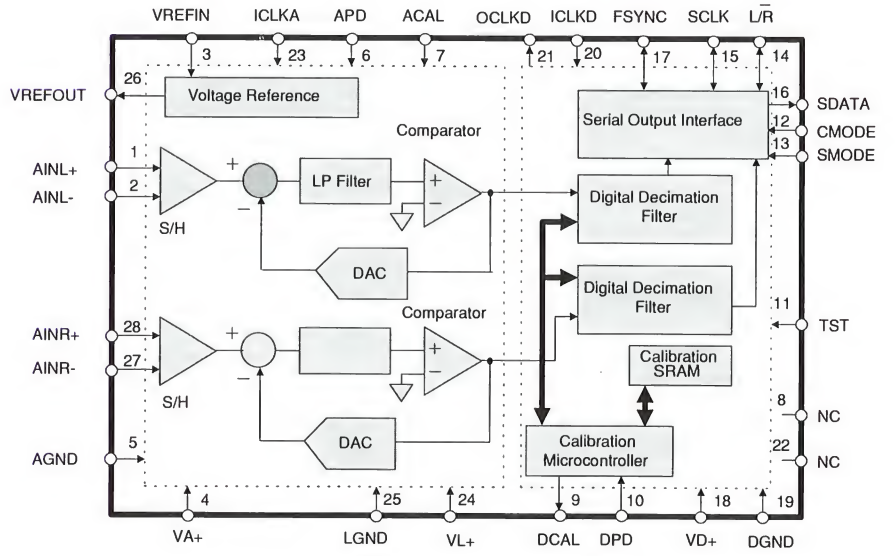
* 1 kHz to 50 kHz output word rate
* 95 dB dynamic range
* Internal 64X oversampling
* SOIC and DIP packages
* Master mode clocking
* 256 Fs or 384 Fs clock



CS5349

Stereo +5V Supply Delta-Sigma Converter

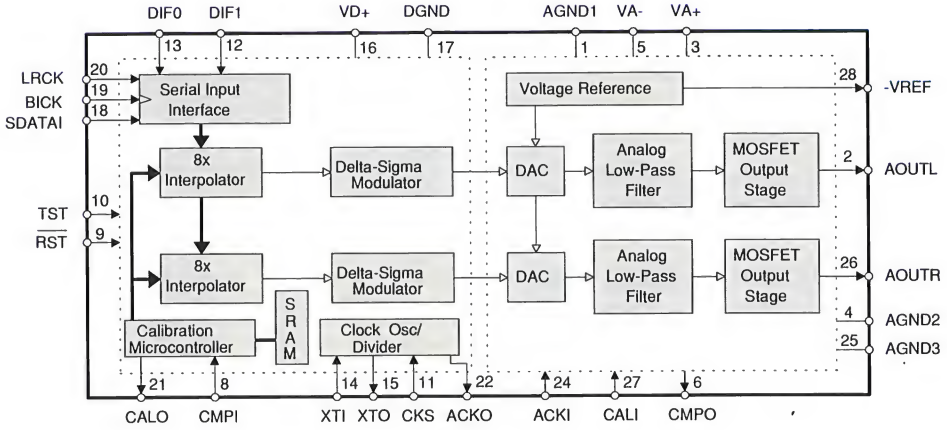
* +5V only supply
* 1 kHz to 50 kHz word rate
* 90 dB dynamic range
* Internal 64X oversampling
* SOIC & DIP packages
* 256 Fs or 384 Fs clock



CS4328

Stereo Delta-Sigma D/A Converter

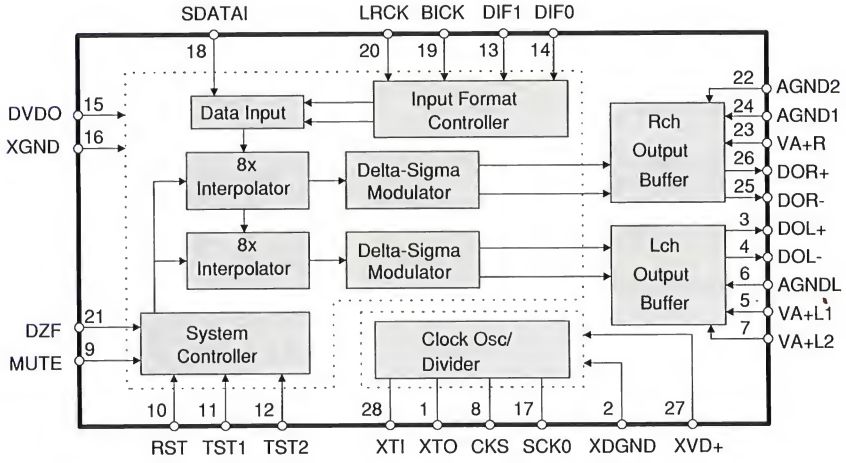
* 1 kHz to 50 kHz input word rate
* 18 or 16-bit input
* 95 dB dynamic range
* No external digital or analog filtering required
* SOIC and DIP packages
* 256 Fs or 384 Fs clock



CS4303

Stereo Delta-Sigma D/A Converter

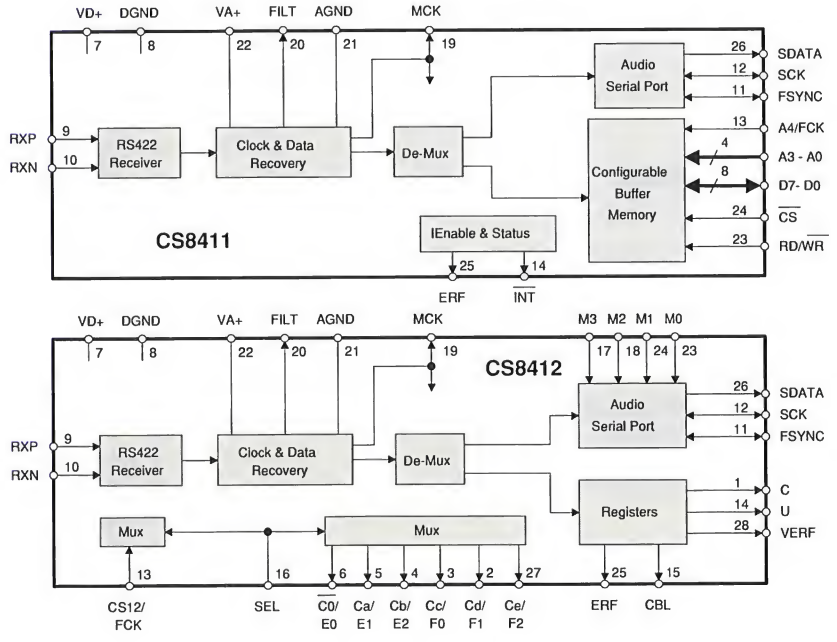
* 64 times oversampling
* 107 dB dynamic range
* Digital Delta-Sigma modulator
* External analog filter



CS8411,CS8412

Digital Audio Interface Receivers

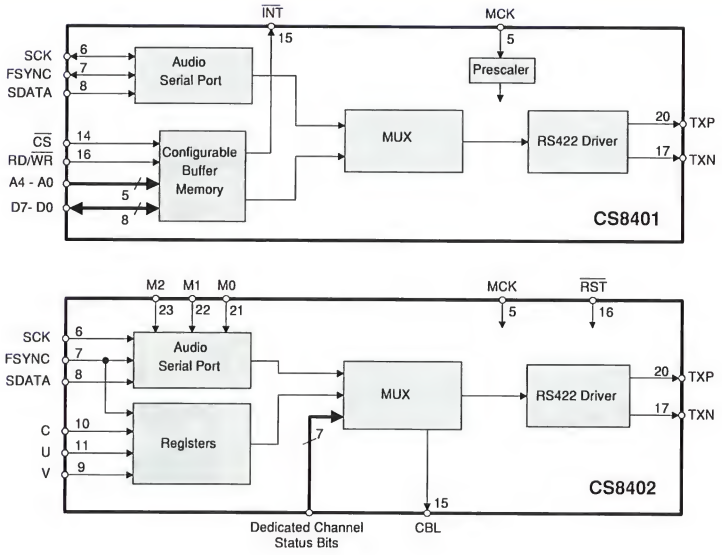
* AES/EBU, IEC958, S/PDIF & EIAJ CP-340 Formats
* On- chip RS422 line receiver
* On-chip low jitter clock recovery
* CS8411 uses host CPU for control and has internal buffer memory
* CS8412 has dedicated pins for channel status information



CS8401,CS8402

Digital Audio Interface Transmitters

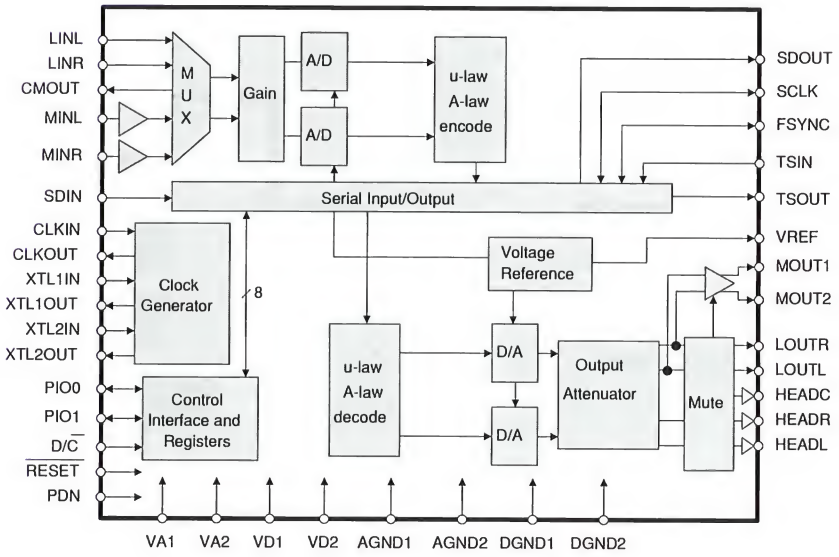
* AES/EBU, IEC958 S/PDIF and EIAJ CP-340 formats
* On-chip RS422 line driver
* CS8401 uses host CPU for control and has internal buffer memory
* CS8402 has dedicated pins for channel status information



CS4215

Stereo Audio Codec

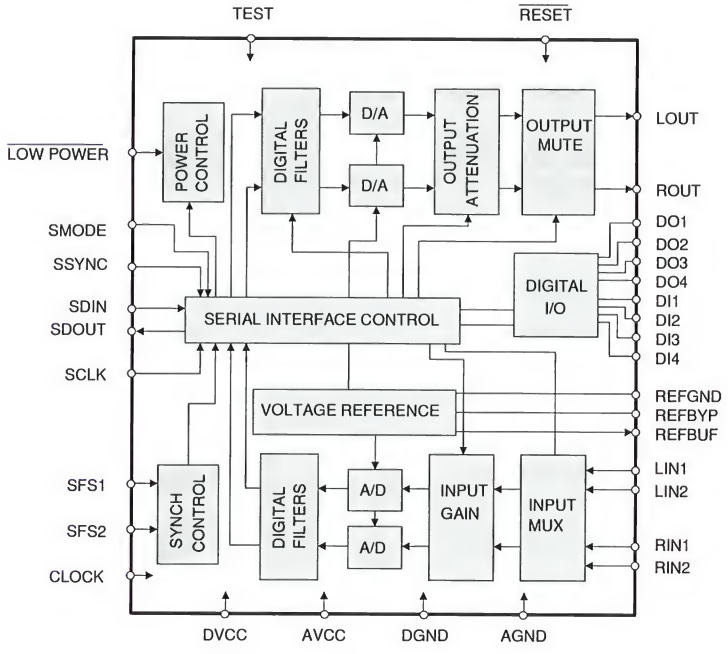
* Dual A/D & D/A converters
* 1 kHz to 50 kHz word rates
* 80 dB dynamic range
* On-chip anti-alias and reconstruction filters
* Input gain and output level adjust
* Headphone and speaker drive
* Microphone Input
* Input monitoring path
* Easy DSP interface
* +5V supply
* 44 pin PLCC package



CS4216

Stereo Audio Codec

* Dual A/D & D/A converters
* 1 kHz to 50 kHz word rates
* 80 dB dynamic range
* On-chip anti-alias and reconstruction filters
* Input gain and output level adjust
* +5V supply
* 44 pin PLCC package



Power Monitor and Watchdog Timer

The CS1232 compares the system power supply to an on-chip, band-gap voltage reference and signals if the supply falls below 4.6 volts. This permits the host microprocessor to power down the system gracefully before the supply fails. Critical system parameters can be saved in non-volatile memory for reinitialization when the power supply returns to rated levels. The CS1232 also contains a watchdog timer and push-button reset circuit.

1 µs, 12-bit Accurate Sample and Hold Amplifiers

The CS31412 and CS3112 sample and hold amplifiers feature on-chip calibration logic for high accuracy. The CS31412 is a four channel simultaneous sample and hold amplifier capable of processing four signal-ended or two differential inputs. With 12-bit accuracy and a fast 1 µs acquisition time, the CS31412 is ideal for processing high-frequency signals. Droop in hold mode is less than 0.001 µV/µs. The device also features output buffer amplifiers, an output multiplexer and a flexible microprocessor interface. Crystal Semiconductor's single channel CS3112 sample and hold shares the fast, accurate performance of the CS31412.

Voltage References

The CS3901 is Crystal Semiconductor's first precision reference. The device features +3.0 V and ±1.5 V outputs which are perfectly suited for use with our CS5412.

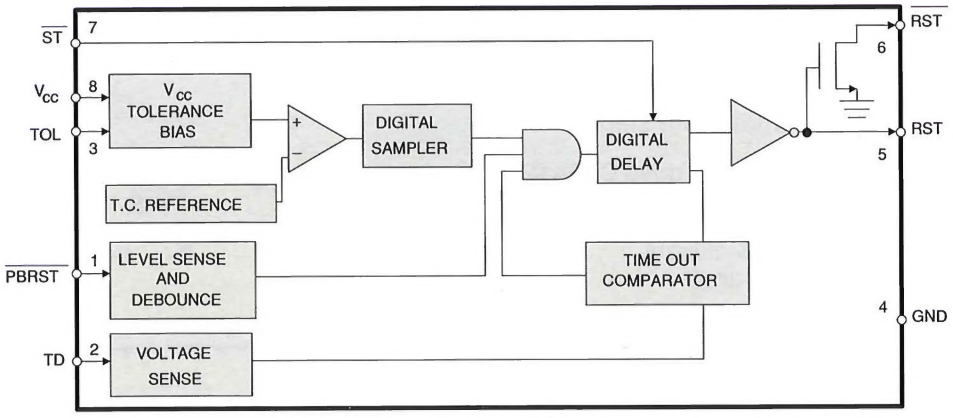
The device only requires ±5 V supplies and is stable to 25 ppm per 1000 hours.

The CS3902 is a precision 4.5 volt reference with an operating voltage of 11 to 22 volts. Featuring very low temperature drift and excellent long term stability, it is suitable for use with all Crystal Semiconductor successive approximation A/D converters.

CS1232

Power Monitor

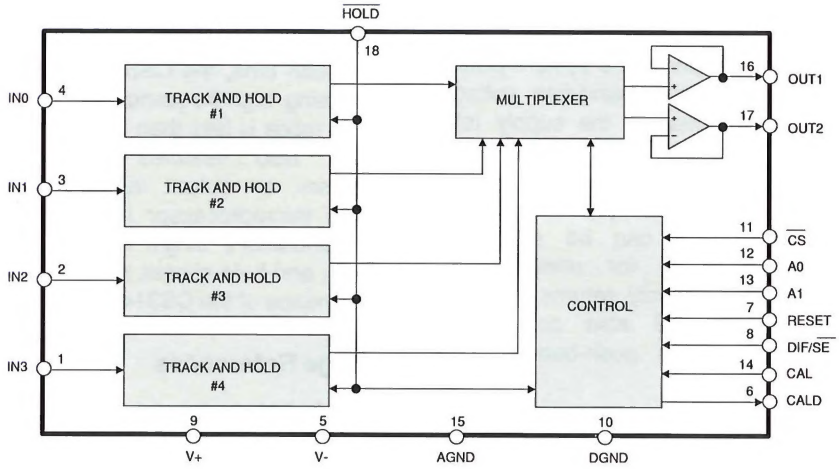
* Monitors +5V supply for -5% or -10% limits
* Watchdog timer
* Push-button reset
* Pin-compatible with DS1232



CS31412

4- Channel Track & Hold

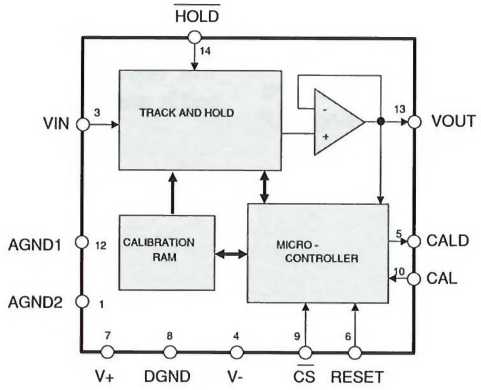
* 800 ns acquisition time
* Simultaneous sampling
* Offset self-calibration
* Low droop rate 0.001 µV/µs
* Built-in hold capacitor
* 18-pin 0.3" DIP package



CS3112

1-Channel Track & Hold

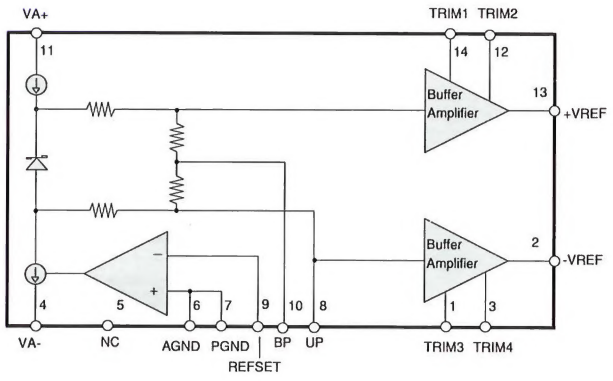
* 800 ns acquisition time
* Offset self-calibration
* Low droop rate 0.001 µV/µs
* Built-in hold capacitor



CS3901

±1.5 V & +3.0 V Voltage Reference

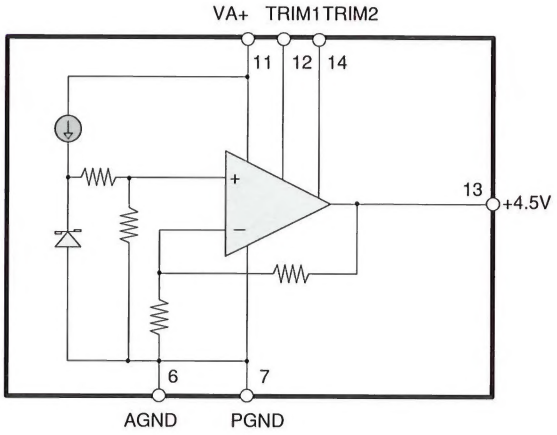
* 0.02% Initial accuracy
* 4 µV/°C temperature stability
* Buffered output to drive CS5412 VREF inputs
* Commercial & military temperature range



CS3902

+4.5 V Voltage Reference

* +4.5 V ±0.4 mV initial accuracy
* ±0.6 ppm/°C temperature stability
* Commercial & military temperature range
* Ideal for all Crystal's SAR ADC's



SUPPORT CIRCUITS

Evaluation Boards and Design Tools

When it comes to support tools for analog circuits, there is none better than Crystal Semiconductor. It starts with our world-class documentation. Our data sheets go far beyond listing device specification and pin assignments. They have all the information needed for a quick design cycle. Most include applications and design hints. All are clearly written and precise. Use the response card to request copies of our latest data books.

Each of our major products is supported with an evaluation board. These high quality boards allow fast device evaluation and often eliminate initial breadboarding. Many users find the layout and ground schemes useful as guidelines in system board design. Finally, our boards can be helpful in the isolation of system problems by comparing in-system performance to the evaluation board performance.

Applications Support

Crystal Semiconductor has one of the best applications engineering groups in the industry. Our specialists are well-versed in our products and their applications. Most have had extensive systems experience, and all are experts on our family of devices. If you have technical or design questions, these professionals will have the answers.

Military 883

Most Crystal Semiconductor devices are designed to operate over military temperature ranges. We can now offer MIL STD 883C Class B compliant production on many of our data acquisition circuits. The CS5012, CS5014, CS5016, CS5101A, CS5102A and CS5412 ADC's have been assigned Standard Military Drawing Numbers by DESC.

Die Availability

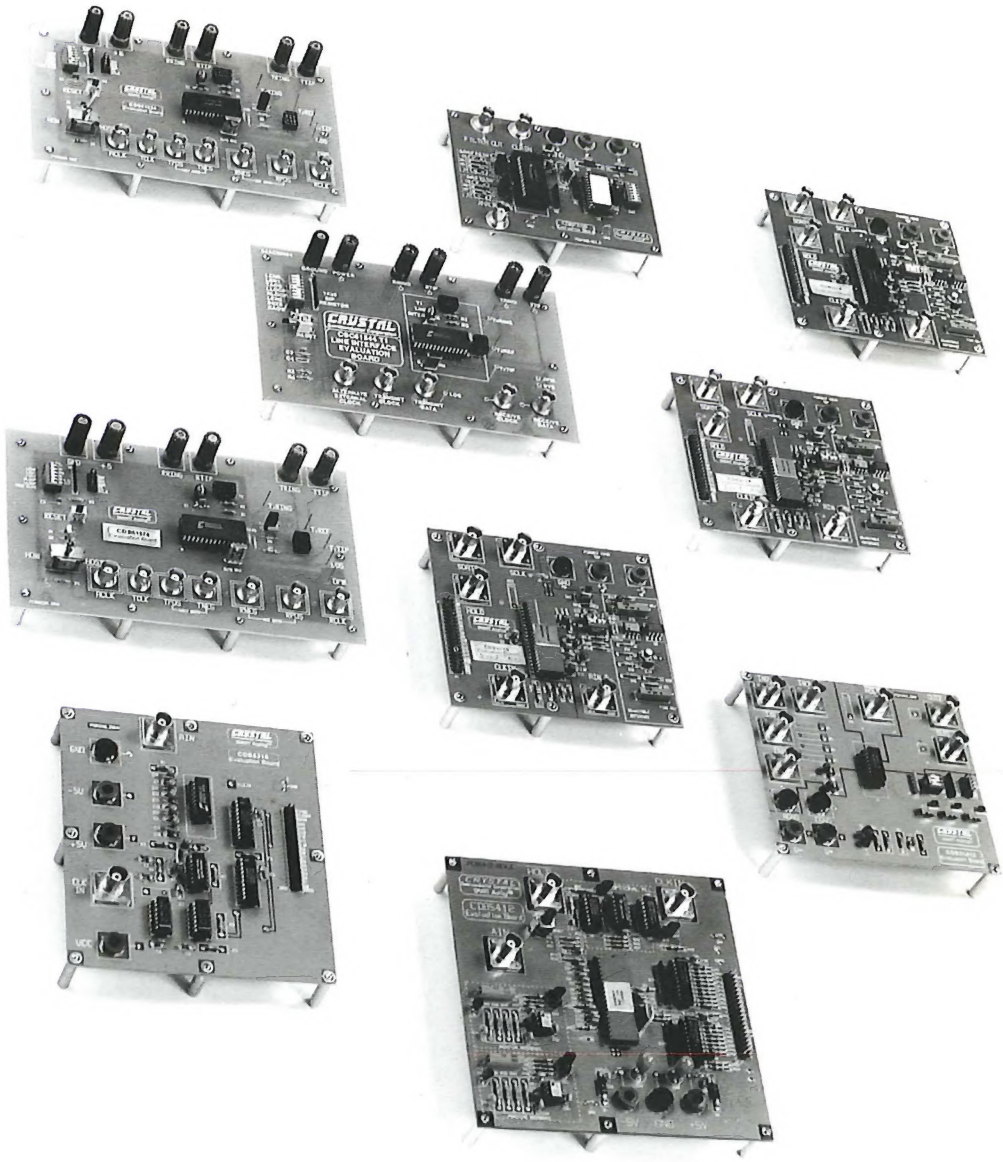
Many Crystal Semiconductor products are supplied in die form to the hybrid IC manufacturing industry. Die data sheets are available on most data acquisition products. Please contact the factory for further information.

Surface Mount

Most devices from Crystal Semiconductor are available with packaging in surface mount, as well as through-hole configurations. Products of 24 pins or less generally use SOIC packages. Parts of 28 pins or greater generally are available in Plastic Leaded Chip Carrier (PLCC). Military 883B and other high temperature devices offer a Ceramic Leadless Chip Carrier (LCC) option.

Sales and Customer Support

Crystal Semiconductor has a sales and support organization which spans the globe. Our sales offices are located in over 20 countries and over 40 cities in the United States and Canada. They are backed by a factory support team that is first rate. Answers to your questions are as close as your local sales representative or area sales office shown overleaf.



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